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SUFFICIENCY REVIEW OF THE DRAFT LAKE PRODUCTIVITY INFORMATION SUBMITTED IN RELATION TO THE NEW PROSPERITY GOLD-COPPER MINE PROJECT

Context

Taseko Mines Limited has proposed the development and operation of a gold and copper mine (New Prosperity Mine), located on the Fraser plateau, approximately 125 km southwest of Williams Lake, British Columbia. The project consists of an open pit mine with a 20 year estimated operating life, and would employ conventional copper porphyry floatation processing. Development of the mine would involve new construction of an open pit, an onsite mill and support infrastructure, a 125km power transmission line, a 2.8km mine access road, a tailings storage facility and ore and waste rock storage areas.

The proposed mine would be located within the Fish Creek watershed, which hosts several fish-bearing creeks and lakes, including Fish Lake, that are likely to be impacted by the development. A previous project submission to CEAA occurred in 2009-2010, but was deemed by a federal review panel and the Government of Canada to have significant adverse environmental affects, and was not approved for development. The current New Prosperity project is a modification of the former development proposal, and the subject of an ongoing Canadian Environmental Assessment Act (CEAA) review (CEAA Registry 11-05-63928).

In June, 2012, Fisheries and Oceans Canada's Pacific Region Ecosystem Management Branch requested Pacific Region Science Branch to conduct an initial review of the draft New Prosperity Gold-Copper Mine Project Environmental Impact Statement (draft EIS; submitted June 4, 2012) for information adequacy and completeness necessary to the proper evaluation of potential effects of mining activities the productivity of Fish Lake.

Specifically,

1. Is the information referenced both sufficient and recent enough for Science to model or assess future productivity of Fish Lake and its tributaries?
2. If not, what other information would be reasonable to request to infer future productivity?
3. Is there enough information to make reasonably informed inferences, or to identify risks associated with data gaps?
4. Are the methods used to assess the potential effects on future productivity of Fish Lake appropriate and executed properly.

A review of the Draft EIS revealed several shortcomings in the modeling approaches and characterization of Fish Lake before, during and after mining operations. In particular, fish productivity models assuming phosphorus limitation of Fish Lake may be of questionable application, and the future effects of climate change, lake eutrophication, and recirculation of lake outflow water to inflows on the thermal regimes and the productivity of Fish Lake have not been fully considered.

This Science Special Response is from the June 26, 2012 Science Special Response review process considering the sufficiency of the lake productivity information submitted in relation to the New Prosperity Gold-Copper Mine project.

Background

Fish Lake is a 112 ha, biologically-productive shallow lake ecosystem located in the Fish Creek drainage of the Fraser plateau. The proposed New Prosperity mine is likely to impact the catchment hydrology supplying Fish Lake, the hydrological and hydrochemical properties of its tributaries, as well as the limnological characteristics of the lake itself. Concern exists over the potential impacts to a non-anadromous *Oncorhynchus mykiss* (rainbow trout) population harvested in both aboriginal and recreational fisheries.

As outlined in the draft Environmental Impact Statement (EIS) produced by Taseko Mines Ltd. > 50% of the upstream catchment area for Fish Lake would be cut off from Fish Lake during the life of the mine. Discharge from the outlet of Fish Lake would be actively captured and pumped up to the remaining reaches of headwater streams to retain inflow to the lake. As noted in the draft EIS, this arrangement is likely to impact the trophic status and ecosystem structure and functioning of Fish Lake, and is a concern for the future biological productivity of Fish Lake in terms of lake habitat and fisheries productivity.

Lake productivity is governed by numerous abiotic and biotic factors, both internal and external to lake ecosystems (Wetzel 2001). In a trophic ecology (food web) context, important regulators of productivity include the availability and proportions of limiting nutrients (i.e., phosphorus and nitrogen) and light for autotrophic production, the efficiency of trophic energy transfers (i.e. algae→zooplankton or benthos→fish; governed by the abundance and species composition of prey items at each trophic level), and water quality parameters (i.e. temperature, pH, oxygen, contaminants) important to the persistence of fish species (Wetzel 2001, Kalff 2002).

Other direct and indirect habitat limitations on fisheries productivity, which can be as influential as food web productivity, include factors that influence reproductive success and the survival of individuals and populations, such as the quantity of suitable spawning habitat (i.e. substrate, pore-water quality), dissolved oxygen availability (i.e. winterkills, hypoxia), sub-lethal and lethal contaminant levels in water and/or sediments, and predation rates (Hartman and Miles 2001).

Lake and river habitats are inherently integrated features of the watersheds from which they originate. , Modifications to terrestrial catchment attributes can have important impacts on abiotic and biotic conditions in downstream aquatic habitats, such as lakes, with commensurate impacts on habitat and fisheries productivity. This connectivity necessitates the consideration of lake productivity in a watershed context.

In this initial review of the sufficiency of information , the draft EIS was reviewed with a focus on aspects of lake habitat productivity and habitat quality that pertain to the trophic ecology of fish, particularly rainbow trout, and to the coupling of the watershed to lake habitat productivity and water quality. DFO Ecosystems Management Branch has deemed the aspects of fish survival and reproductive success related to contaminant loading and fish contaminant burdens to be the jurisdiction of Environment Canada. Therefore, contaminant influences on lake productivity (i.e., food web impacts) have not been considered here.

Analysis and Responses

The following are responses to questions posed by DFO Ecosystem Management Branch regarding the Taseko Mines Ltd. New Prosperity Mine Environmental Impact Statement.

1. ***Is the information referenced both sufficient and recent enough for Science to model or assess future productivity of Fish Lake and its tributaries?***

Preface

As the New Prosperity draft Environmental Impact Statement (EIS) relies heavily upon the data and analysis conducted in the 2009-2010 process, and access to these prior materials during the brief review window was not available, it was difficult to assess the sufficiency of the data that will be used for future review. However, DFO Science provided advice to DFO Ecosystem Management Branch during the previous submission (2009-2010), and several inadequacies were noted in the data at that time. As such, some inferences about the data quality and representativeness for a future review could be reasonably made.

Information Sufficiency and Recentness

In general, predictive modeling has been attempted for many of the anticipated impacts of the New Prosperity mine on Fish Lake habitat and fisheries productivity. These predictions include changes in catchment area, altered flow volumes, changes in the nutrient chemistry of Fish Lake and its tributaries, and changes in biological productivity. However, omissions of predictions forsome key factors likely to influence lake and its fisheries productivity have been noted (see responses to Question 2), which limit a full assessment of the future productivity of Fish Lake and its tributaries.

2. ***If not, what other information would be reasonable to request to infer future productivity?***

Climate Change

Climate change is likely to be the primary large-scale driver on future water distribution and quality (IPCC 2007), with climate variability being a major factor in aquatic ecosystem structure and functioning (Walther et al. 2002). Climate change was only cursorily addressed by the proponent in the draft EIS, and the effects on water distribution (surface hydrology) indicated to be "*accounted for*" (pg. 578). Further information on anticipated impacts of climate change on the system, and how they were accounted for are necessary to fully assess the adequacy of the approach, as total water availability, evaporation, inflows and discharge,lake thermal structure and seasonal productivity patterns will be affected by changes in precipitation and temperature resulting from climate warming. Regional climate models should be incorporated into the estimations of water quantity and quality, and projected, at a minimum, over the next century (including the 20 year life of the mine), to assess additive and interactive effects on lake and fisheries productivity. Such a long-term perspective is consistent with the timeline for the groundwater seepage modeling.

Mitigation Measures to Protect Aquatic Ecology

The draft EIS indicates that mitigation measures will be undertaken for the protection of water and sediment quality to buffer any impacts on Fish Lake productivity, and implemented based upon the results of a routine monitoring program. It is unclear what mitigation measures would be undertaken for specific impact scenarios. To fully evaluate the efficacy and feasibility of such

measures to protect the productivity of Fish Lake, particularly for rainbow trout, more detail is required.

Water Diversions, Limiting Nutrients Lake Trophic Status, Lake Ecology and Fish Productivity

The primary limiting nutrients to autotrophic productivity in lakes (and thus the basis for food web productivity for fish) are nitrogen (N) and phosphorus (P). The modeling efforts in the draft EIS and previous submission characterize Fish Lake as a P-limited system. Explicit presentation of existing and predicted P and N data are required to assess the projected N and P changes so that fish production models and lake ecosystem attributes before, during and after mine operation can be validated. The proponents note, with to respect to their water quality modeling, that "*The predictive accuracy of the models is entirely subject to the quality of the inputs to the models and appropriateness of the assumptions.*" (Page 646). As such, nutrient data, an assessment of nutrient limitation, and water quality model outputs are required to assess whether model selection is appropriate. This was a critical point raised by Science, during the 2009-2010 review process.To assess the baseline and future nutrient limitation in Fish Lake, and the commensurate food web impacts on fisheries productivity, it is important that raw data for the different species of N and P be presented. These data should include biologically-available inorganic dissolved forms of N and P (e.g. total dissolved phosphorus or soluble reactive phosphorus; nitrate/nitrite) and estimates of total N and P that include all dissolved and particulate pools (i.e. TN and TP), such that nutrient limitation can be fully understood.

As noted in the draft EIS, the catchment for Fish Lake will be sizably reduced (>50% during the life of the mine), changing the hydrology of the watershed, and the chemical and biological properties of Fish Lake. Using modeling approaches, the draft EIS indicates "*... the trophic status of Fish Lake will remain largely unchanged with reduced flow as long as water draining out of fish lake is recirculated back to Upper Fish Creek's spawning and rearing habitats, and ultimately into Fish Lake....*" (pp. 758), and that permanent eutrophication of Fish Lake will occur with mine closure "*...during mine closure and post-closure phases, Fish Lake trophic status may shift from being meso-trophic to a more highly productive eutrophic lake...*" (pp. 759). Modeling predictions in the draft EIS suggest a more than doubling of total phosphorus concentrations and algal productivity (as measured by chlorophyll *a*).

It is worth noting that "highly productive" lakes do not necessarily equate to those with better fish habitat or productivity, as eutrophication can cause cascading impacts on food-web composition, induction of N-limitation, depletion of dissolved oxygen, entrainment into a eutrophication amplification feedbacks via internal P-loading from sediments, and severe winter fish kills (Smith and Schindler 2009). The assessment of future lake and fish productivity will require accurate modeling of future nitrogen and oxygen conditions within Fish Lake.

Lake temperatures can strongly influence lake productivity through strength and duration of stratification, and availability of nutrients (Wetzel 2001). Moreover, lake temperature can have strong negative influences on growing-season oxygen concentrations, particularly in mesotrophic to eutrophic systems (Wetzel 2001, Kalff 2002, Smith and Schindler 2009). The draft EIS does not appear to predict the effects of warming lake temperatures, particularly during summer, either as a result of climate change, or as expected once the inflows are reduced and the lake's water supply is largely dependent upon recirculated lake water. The influence of recycled lake water on the thermal regime of Fish Lake, and the associated impacts on the lake ecosystem are essential to understanding the future lake and fisheries productivity of Fish Lake.

3. ***Is there enough information to make reasonably informed inferences, or to identify risks associated with data gaps?***

As noted in Question 2, there are critical information gaps surrounding the characterization of future lake conditions (i.e. N-availability, oxygen-availability, lake temperature), which unless accurately modeled, will compromise the ability to make reasonably informed decisions on the impacts to lake and fish productivity. Failure to have these data represents a critical data gap, and will likely result in a more conservative and precautionary approach to assessment of the potential impacts of mine development on the productivity of Fish Lake.

4. ***Are the methods used to assess the potential effects on future productivity of Fish Lake appropriate and executed properly.***

Although the analyses presented are methodologically sound, in light of the omissions noted above, the approaches presented in the draft EIS are not sufficiently comprehensive to enable full environmental evaluation of impacts of the New Prosperity project on the productivity of the Fish Lake. This review did not consider model outputs and appendices of data; these components should be included in a complete assessment of the validity of methodologies.

Conclusions

This draft EIS builds upon a former CEAA project submission that was deemed by a federal review panel and the Government of Canada to have significant adverse environmental affects, and was not approved for development. While access to materials from the first submission during the brief review period was unavailable, DFO Science's prior involvement in the previous CEAA review (2009-2010), and familiarity with the proponent's prior characterization of Fish Lake, enabled inferences about data quality and representativeness for a future review to be reasonably made.

A review of the draft New Prosperity mine EIS revealed an intensive effort by the proponent to model the physical, chemical and biological impacts of mine development on the productivity of Fish Lake. However, several shortcomings in the modeling approaches and characterization of Fish Lake before, during and after mining operations were identified. In particular, fish productivity models assuming phosphorus-limitation of Fish Lake may not be appropriate. Moreover, the future effects of climate change, lake eutrophication, and recirculation of lake outflow water to inflows on the thermal regimes and the productivity of Fish Lake have not been fully considered. Failure to adequately characterize the future conditions for Fish Lake and its tributaries contribute uncertainty about predictions of future habitat and fisheries productivity of the system.

Contributors

Daniel T. Selbie	DFO Science, Pacific Region
Michael Bradford	DFO Science, Pacific Region
Erland McIsaac	DFO Science, Pacific Region
Marilyn Joyce (editor)	DFO Science, Pacific Region

Approved by

Mark Saunders, Manager
Salmon and Freshwater Ecosystems Division
Science Branch, Pacific Region
Fisheries and Oceans Canada

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Center for Science Advice (CSA)
Pacific Region
Fisheries and Oceans Canada
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, British Columbia
Canada, V9T 6N7

Telephone: 250-756-7208
E-Mail: CSAP@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas-sccs/

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